Experimental study on identification of aerodynamic damping matrix for an operating wind turbine by artificial excitation

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Abstract

Quantitation of damping is of great significance for the design and condition assessment of wind turbines. The authors' previous theoretical and numerical studies showed that compared to damping ratios, a modal aerodynamic damping matrix can better describe the damping coupling in the fore-aft (FA) and side-side (SS) tower motions. In the present study, an improved damping identification method was first proposed to identify this damping matrix with artificial exciters and then verified by using OpenFAST simulations under different excitation frequencies, excitation force amplitudes, and different turbulent wind fields. Following the numerical study, a scaled wind turbine model with a geometric scale ratio of 1/75 was carefully designed based on the NREL 5 MW wind turbine prototype, in which the scaled blade design follows the rule in thrust coefficient similarity. An identification study was performed with this scaled model by a series of wind tunnel tests. The modal aerodynamic damping matrix was identified under steady-state harmonic excitation in the operating state and compared with the identified results by a free decay method and the theoretical values. The results experimentally confirm the correctness of the aerodynamic damping matrix theory under uniform wind and the feasibility of the improved identification method in practice.

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